Down the Road:

The Effects of Roads and Trails on Wildlife

Yukon Fish and Wildlife Management Board

The Yukon Fish and Wildlife Management Board is an advisory body consisting of 12 members. Six members are nominated by the Council of Yukon First Nations and six by the Yukon Government. The Board was created through the Yukon Umbrella Final Agreement as "the primary instrument of fish and wildlife management in the Yukon." The Board deals with the conservation and management of fish, wildlife, habitat and wildlife users on a territory-wide basis.

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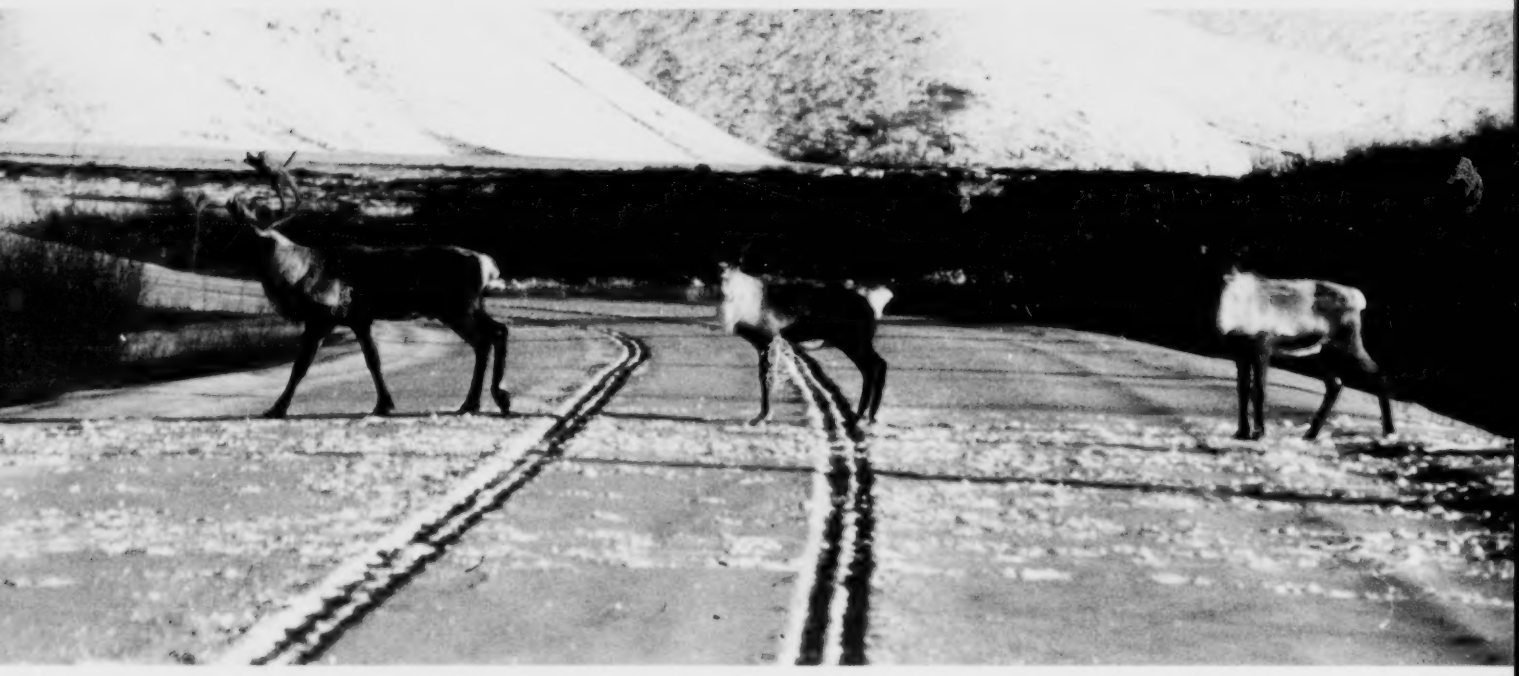

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Contents

5 Introduction

7 Direct Effects

7 Collisions with Vehicles
8 Habitat Damage
12 Linear Disturbance

16 Indirect Effects

16 Wildlife Disturbance
19 Harvest of Fish and Wildlife

21 Cumulative Effects

23 Increased Access for Industry

24 Reducing the Effects of Roads and Trails

25 Is a Road Really Necessary?
28 Land Use Planning
30 Design and Construction of Roads
34 Location of Disturbance
35 Restoration

36 Access Management

37 Hunting and Fishing
38 Off-Road Vehicles
40 Controlled Access

41 What You Can Do

41 Reporting Wildlife Disturbance and Habitat Damage
42 How Off-Road Vehicle Users Can Reduce their Impact
43 Road and Trail Restoration

46 Photo Credits

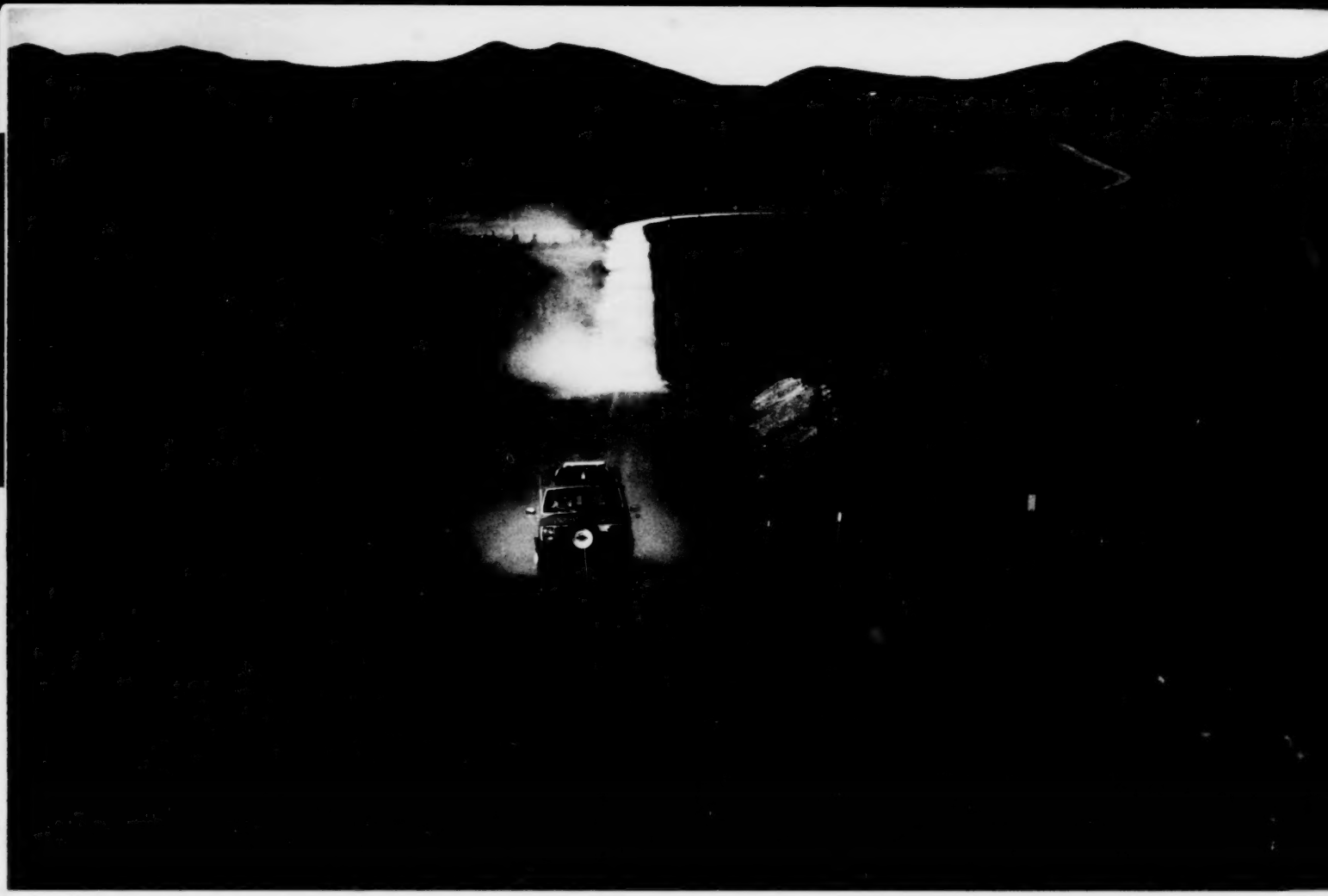
47 Selected References

Introduction

The Yukon Territory is known for its vast wilderness.

Development of roads and trails into this wilderness brings many benefits: access to natural resources, new hunting and fishing areas and recreational opportunities.

Unfortunately, roads and trails can have negative effects on fish and wildlife and their habitat.



Roads are built to access homes and communities and to explore for and extract natural resources such as minerals, oil, gas and timber.

Trails can be created along pipelines, power lines and seismic lines. They are often built for recreation.

New trails are also created when people leave established roads and trails on foot or with off-road vehicles.

Roads and trails have both direct and indirect effects on wildlife and wildlife habitat. This publication is intended to provide information about these effects and how they can be reduced through planning, construction, location, access control and restoration.

In the Yukon we have the opportunity to learn from other parts of North America, many of which are now encountering problems that the Yukon could also face if we are not pro-active in finding solutions that suit the Yukon.

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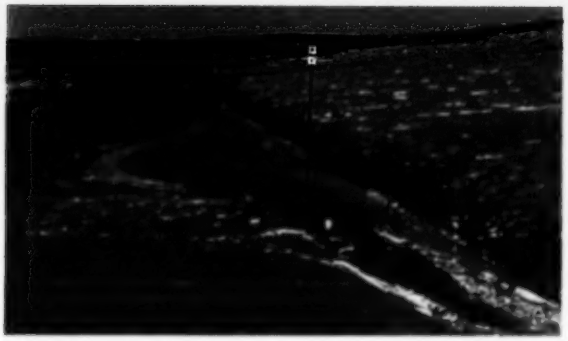
DIRECT EFFECTS

- Each year many animals, including **bears, elk, moose and caribou are killed by vehicles on roads.**
- Moose are killed on roads most frequently in winter when deep snow limits their movements outside of ploughed rights-of-way.



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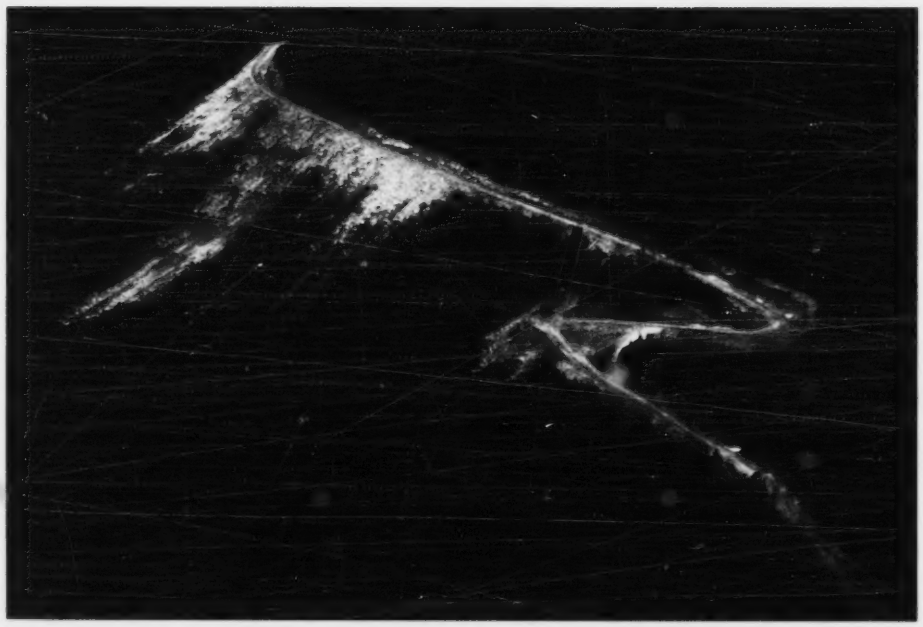
DIRECT EFFECTS

Habitat Damage

If roads are not carefully built and maintained they can be damaging to fish habitat.

The removal of vegetation near streams during construction can cause an increase in stream sediment and temperature. An improperly built culvert will stop fish from migrating upstream. This may force fish to spawn in unsuitable sites or not spawn at all.

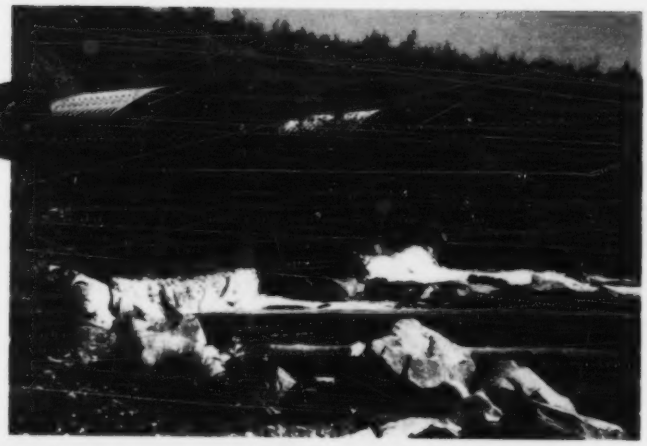
Even when roads do not cross streams, they can still affect them.



For example, an eroding road can affect water quality in nearby streams.

Roads can also encourage the dispersal of new plant species that can out-compete native plant species, and change the nature of the ecosystem.

A road that causes erosion can affect nearby streams
Photo: Wayne Sawchuk



If culverts at road crossings are too high, fish will not be able to pass. If culverts are too steep the water inside them will move too quickly for fish to swim against it.

Photo: Department of Fisheries and Oceans

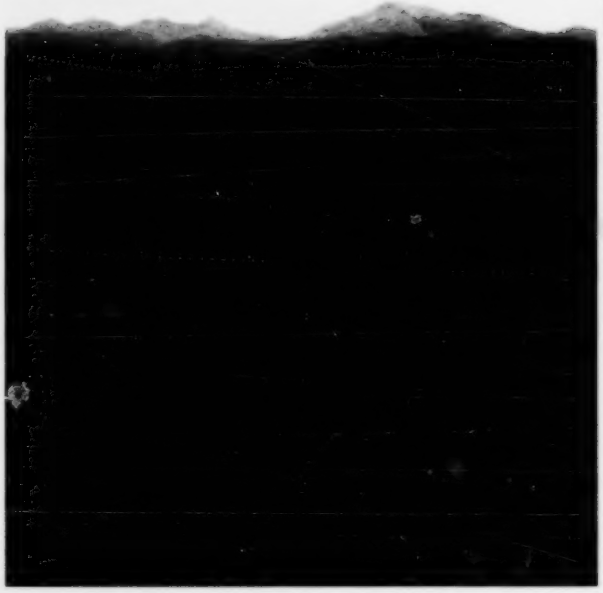
- Increased sedimentation in streams can affect the development of fish eggs and be harmful to invertebrates that fish feed on.

- Increased water temperature can cause migratory disruption, a decrease in reproductive success and an increased vulnerability to disease.

- Vegetation along a stream is known as 'riparian vegetation.' Riparian vegetation shades streams and keeps them cool. It also provides a food source for fish and debris that shelters fish in the stream.

Habitat Damage

Compacting of snow by snowmobiles lowers the temperature beneath the snow and reduces the over-winter survival of plants, soil microbes and even small mammals.



In Wrangell-St Elias National Park trail braiding is the result of ATV drivers creating new trails as they try to avoid wet spots on existing trails. Photo: Wrangell-St. Elias National Park

In Wrangell-St. Elias National Park in Alaska, use of ATVs is allowed to provide access for stakeholders with private property and exploration rights in the park.

ATVs have caused serious habitat damage.

In response, the National Park Service has researched different methods for hardening trails to prevent ponding and trail braiding. They have also researched where to put trails so that they will have the least impact on vegetation. They found that areas that are most easily damaged by ATVs are moist areas and low shrub vegetation communities found on cold and wet permafrost soils.

Dryas and tall willow communities found on coarse well drained cobble, gravel and sand substrate are the most resistant to the effects of ATVs.

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Habitat damage from ATV's at Mclintock, at the north end of Marsh Lake, Yukon. This was important habitat for the Southern Lakes caribou herd.

Photo: Rob Florkiewicz

DIRECT EFFECTS

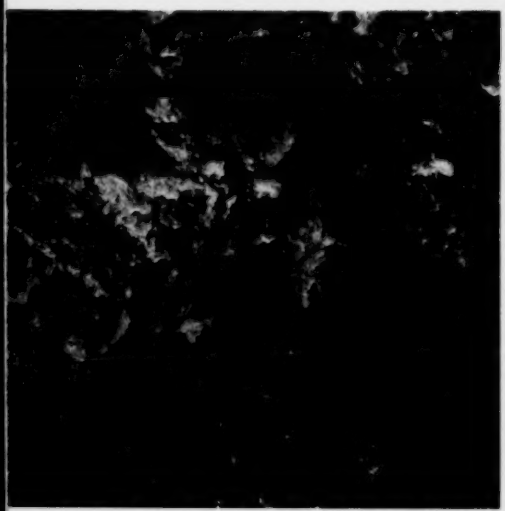
Linear Disturbance

Roads, seismic lines and transmission lines that break up the landscape are called 'linear disturbance'. Linear disturbance fragments habitat and prevents wildlife from fully using it.

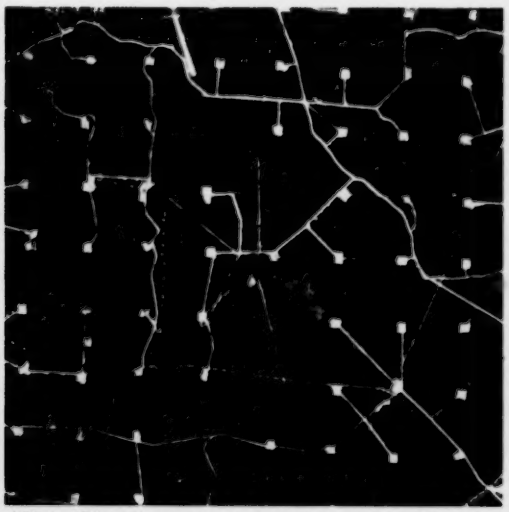
Animals are more likely to use larger and less interrupted areas of habitat.

In the Western Canadian Sedimentary Basin, which runs through Alberta and British Columbia, there is an average of 2.4km of linear development for each square kilometre of area. Sensitive wildlife populations such as wolves are rarely found in areas with more than 0.45km of roads per square kilometre. This development has divided the region into 11,978 separate pieces. Of these pieces, only 6% are larger than 9km^2.

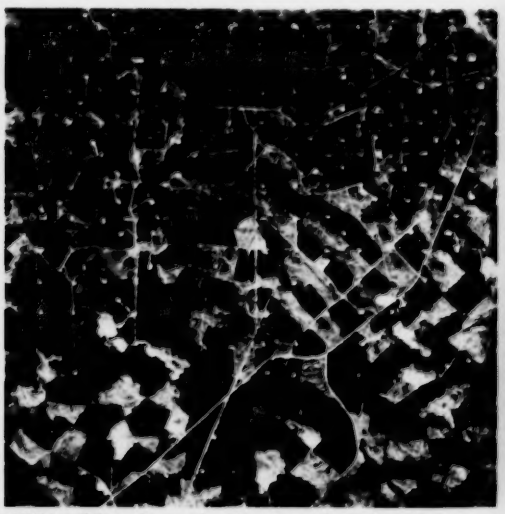
Aerial view of area surrounding Swan Hills, Alberta over 50 years.



1949 - Wilderness with no development.



1964 - Oil and gas development and corresponding roads.

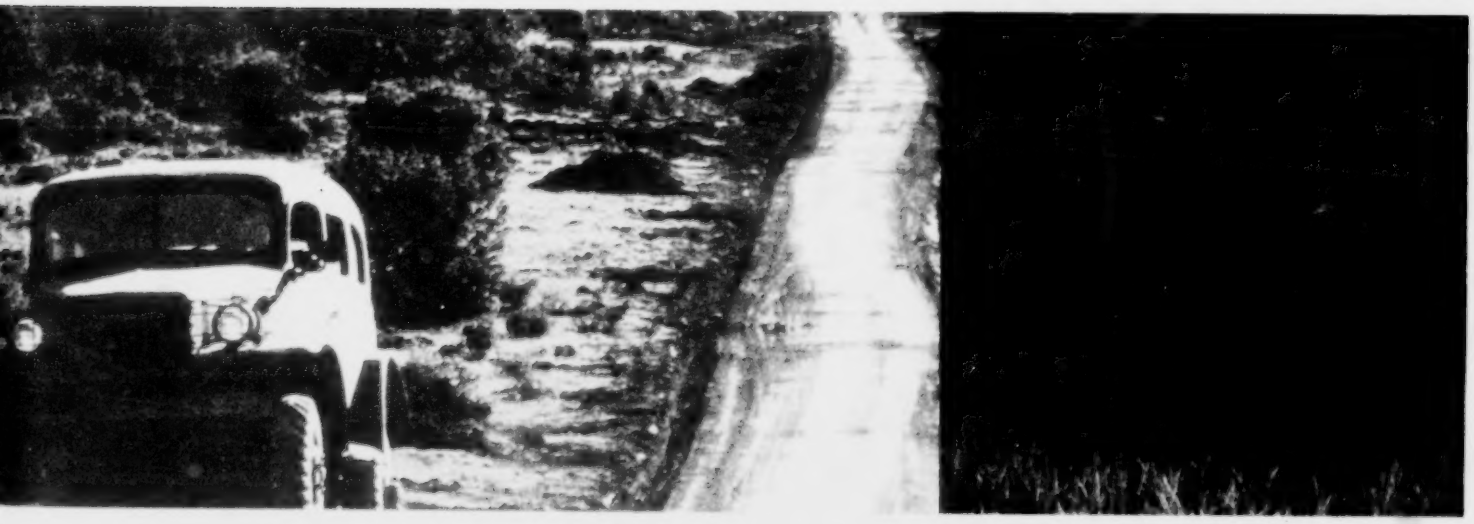


1991 - Oil and gas development, forestry clear cuts and corresponding roads.

Roads are often built on valley floors, floodplains and south-facing slopes.

Many roads and trails are placed in areas with high habitat value for wildlife because conditions make it easier and cheaper to build in these areas.

These places are key seasonal ranges for moose, caribou, sheep and other animals. Roads can alter animal behaviour by causing them to shift their home range, avoid roads or begin using roads for travel.



Habitat Fragmentation

Many animals will avoid not just the road itself, but also all the land for a certain distance on either side of the road.

In Alaska, scientists found the higher the density of roads the lower the density of caribou.

Barren ground caribou tend to avoid roads. Roads have also been found to act as a partial barrier to the movement of woodland caribou. Elk may avoid roads, pipelines and transmission lines, depending on the season and whether or not the population is hunted.

Corridors such as pipelines and transmission lines may increase forage (food such as grasses and shrubs) for animals.

Some animals will also use snowmobile trails and seismic lines because they are easier to travel on. In some cases this may be a benefit, but it can be a problem if it increases an animal's vulnerability to predation, hunting or collisions with vehicles.

For instance,

Snowmobile trails and seismic lines provide an easy means of travel for wolves and increase wolf success in hunting caribou.

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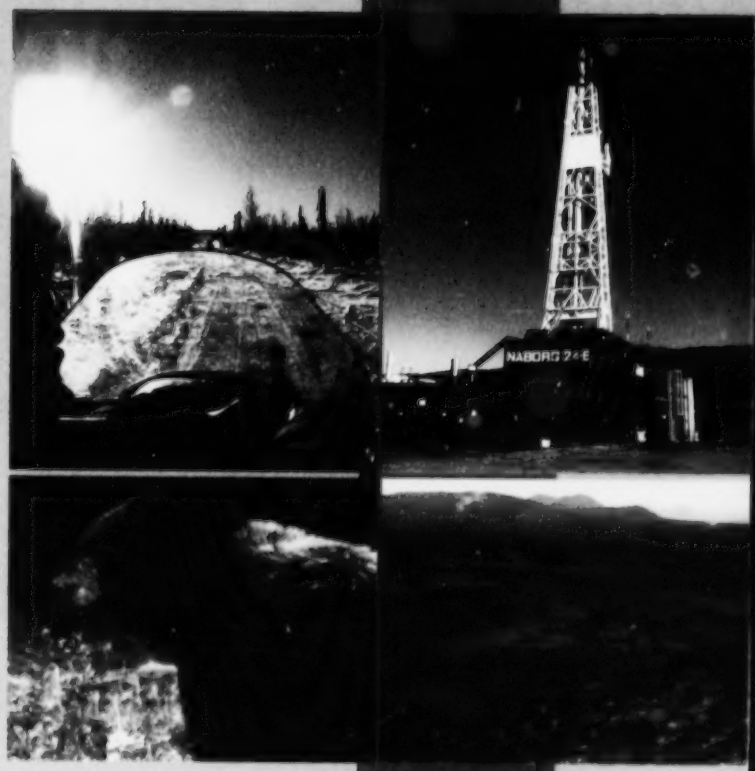
INDIRECT EFFECTS

The effects of roads go beyond their footprint on the land.

Roads create access to wilderness areas.

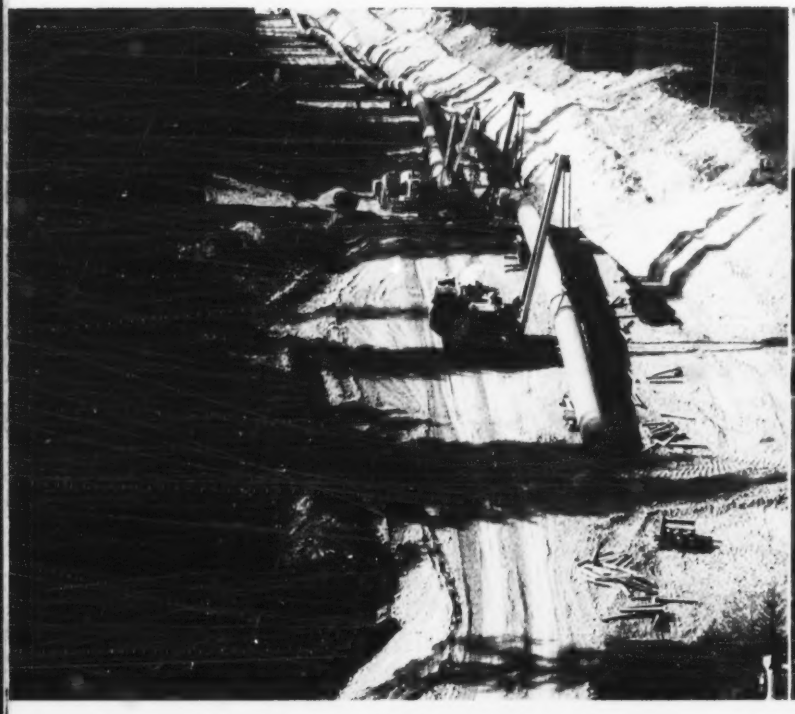
The impacts people have on wildlife, as a result of this easier access to wilderness areas, are the indirect effects of roads.



"The moose population certainly seemed to be more plentiful then. But there weren't very many aircraft around and there weren't any all-terrain vehicles and most of these lakes didn't have any trails or roads going into them. The only way they got to them was with the outfitters with horses."

- resident discussing moose populations in the Yukon's Coast Mountains

Wildlife Disturbance



People accessing wilderness areas can disturb wildlife.

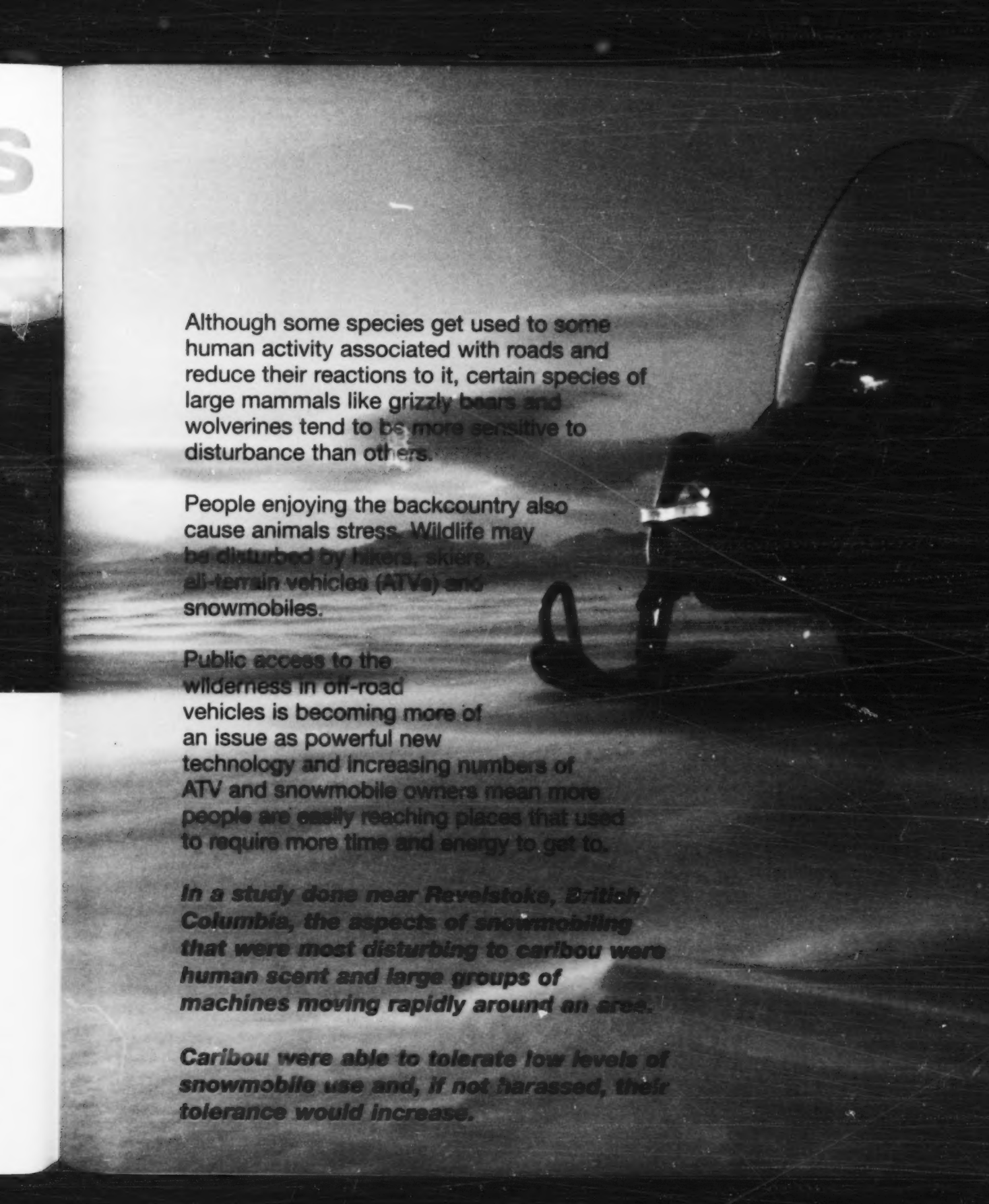
Disturbance causes stress to animals. Stressed animals use up critical energy reserves by running away or moving around more than usual.

This is especially important at critical times of year. For caribou and moose these are the fly season, very cold weather in winter, late pregnancy and calving time. Stress and exertion can threaten an animal's survival and mean the difference between the birth of healthy or unhealthy young in the spring.

Disturbance can also cause animals to leave the best habitat.

Some animals have traditional patterns which, if repeatedly interrupted, can lead them to permanently abandon their habitat. This can mean giving up the safest place or the place with the most available food, and over the long term this will affect their health and survival.

Many birds will abandon their nests if exposed to human disturbance.



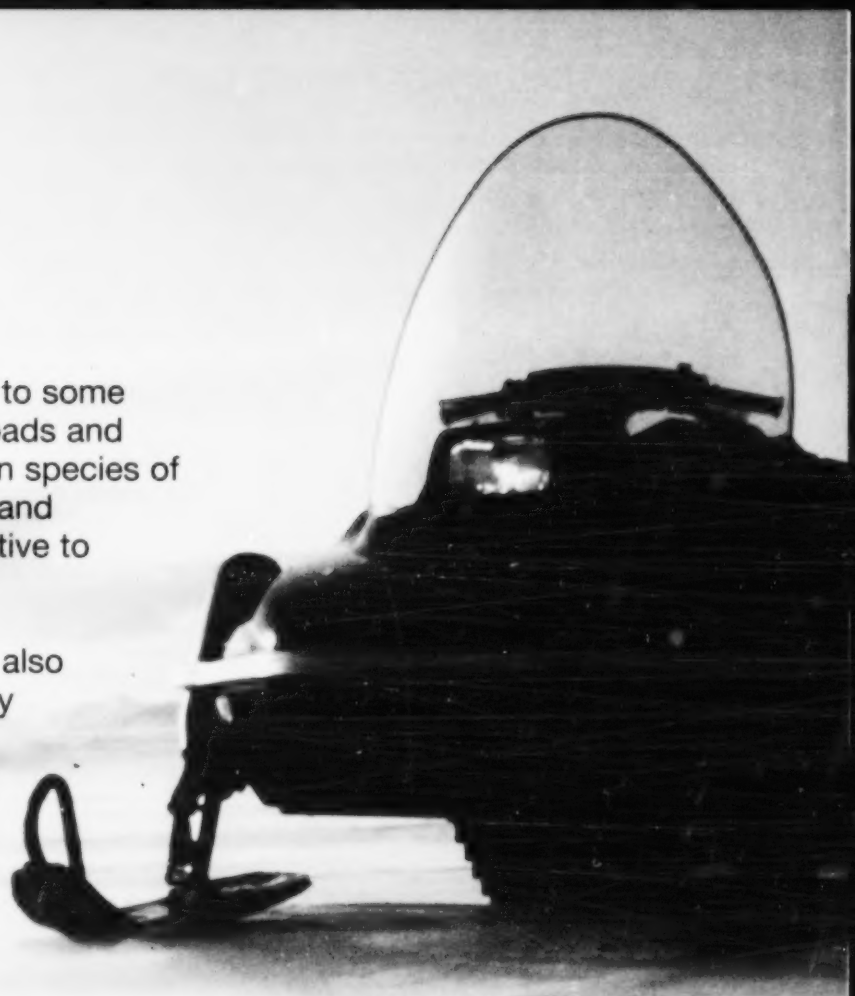
Although some species get used to some human activity associated with roads and reduce their reactions to it, certain species of large mammals like grizzly bears and wolverines tend to be more sensitive to disturbance than others.

People enjoying the backcountry also cause animals stress. Wildlife may be disturbed by hikers, skiers, all-terrain vehicles (ATVs) and snowmobiles.

Public access to the wilderness in off-road vehicles is becoming more of an issue as powerful new technology and increasing numbers of ATV and snowmobile owners mean more people are easily reaching places that used to require more time and energy to get to.

In a study done near Revelstoke, British Columbia, the aspects of snowmobiling that were most disturbing to caribou were human scent and large groups of machines moving rapidly around an area.

Caribou were able to tolerate low levels of snowmobile use and, if not harassed, their tolerance would increase.



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Wildlife Disturbance

It is difficult to accurately measure the impact that ATVs and snowmobiles might have on wildlife. It depends on the type of animal, the number of machines near a group of animals, the place and the time of year.

Skilled and responsible drivers have less of an impact on wildlife. Driving slowly and at a distance from an animal will have less of an impact than driving fast and deliberately approaching an animal.

- Mountain caribou in BC moved out of the part of their range that was highly accessible to snowmobiles. It was used more by caribou after snowmobiles were prohibited than before.

- In the spring when bears emerge from their dens they are physically stressed and are more likely to be impacted by disturbance from snowmobiles.

- Alaska Department of Fish and Game biologists in the Talkeetna Mountains near Denali show increasing recreational snowmobile use is beginning to change moose use of preferred treeline willow habitats. Moose are especially dependant on these habitats in the winter.

- In Whitehorse-Southern Lakes areas biologists are concerned snowmobiles may be disrupting the Southern Lakes caribou, parts of whose winter range is regularly used for snowmobiling.

INDIRECT EFFECTS

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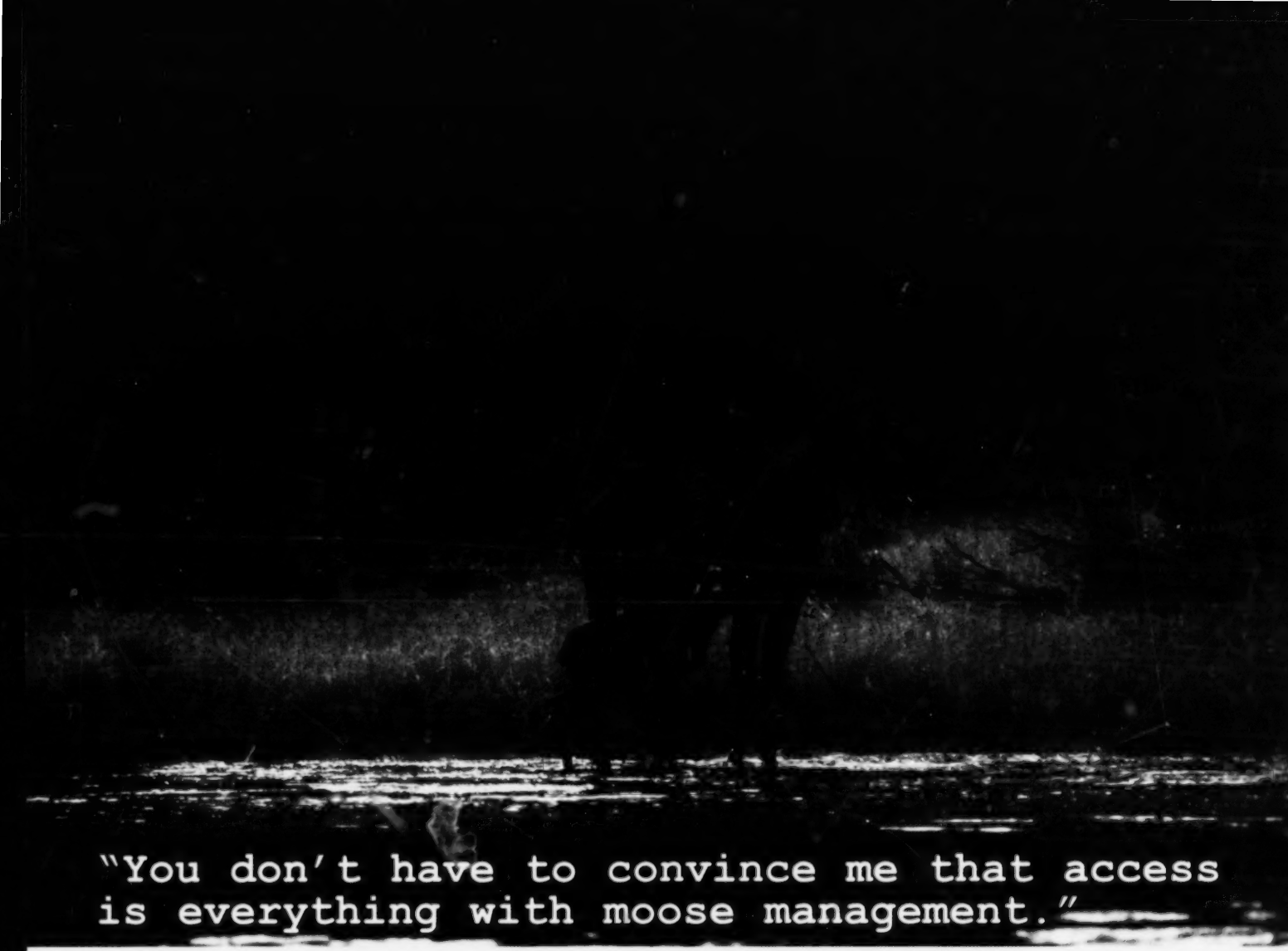
Harvest of Fish and Wildlife

Roads and trails make new areas easily accessible for hunting and fishing. While this can be seen as a benefit it is often detrimental to fish and wildlife and can lead to depletion of populations.

A study done in British Columbia's Rocky Mountains found that between 1971 and 1998 all the grizzly bears killed by humans (96 bears) were killed within 500 metres of a road or trail.



"You don't have to convince me that access is everything with moose management."

I think once a road is punched in, without accompanying regulation, time and time again, bears and wolves aside, we've decimated those populations. Probably the most drastic one I've seen is over here in Kusawa West on what I call Red Squirrel Creek Road leading up in towards Granite Lake. That one was punched in during the 1970's as a result of a placer mining interest. Once people became aware of that road, moose were just hammered in there, absolutely hammered." *- resident discussing moose populations in the Yukon's Coast Mountains*

CUMULATIVE EFFECTS

The combination of all the different impacts in an area over time is called **'cumulative effects.'** **Some of the effects of roads and trails may seem small when taken on their own, but when all kinds of effects for past, present and future roads and trails are combined, they can have an immense impact on wildlife.** It is important to consider what the cumulative effects will be before a road or trail is built.

CUMULATIVE EFFECTS

Around Fish Lake, Rose Creek and Alligator Lake (southwest of Whitehorse) moose numbers have declined dramatically. **These places are easily accessible and frequently visited. In more remote areas moose numbers have remained at or near historic levels.**

Increased Access for Industry

- New roads provide increased access to industries as well as individuals.
- When a road is built into a wilderness area, it becomes more economical for companies to access that area for their own resource extraction.

Owners of mineral tenures may expect to be allowed to use new industrial roads.

Building a road to access a resource may mean a larger eventual impact with further development of timber, mineral, oil and gas resources.

New roads may branch out from the original road.

Top: Gas drilling platform with clearcut in background. Bottom: The road constructed for oil and gas was used later for logging.

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REDUCING EFFECTS

There are a variety of techniques that can be used to reduce the impact of roads and trails on wildlife and wildlife habitat. The effects of roads and trails can be mitigated (reduced) during planning, construction and after road and trail development.

People come to value wildlife and natural areas by enjoying them. Designated trails encourage people to get outdoors. They also focus recreational use in certain areas. This prevents widespread habitat damage and access to sensitive areas.

Is a Road Really Necessary?

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The best way to avoid the impacts of roads is not to build them in the first place.

It is important to consider all the options and determine if access can be obtained without a road.

For instance, flying in supplies and crews is another alternative to building a road.

As well, using existing roads and cleared rights-of-way, even if they have to be upgraded, can be more economical and have less environmental impact than building a new road.

Is a Road Really Necessary?

Low-impact winter roads (ice or snow-packed roads) minimize the amount of disturbance to the soil and limits the creation of long term access for the public.

Upper Chicken Creek, BC

The Upper Chicken Creek valley in northern British Columbia is home to caribou and moose in the winter and grizzly bears and elk in the summer. When Murphy Oil proposed building two natural gas wells in the valley, there was concern that roaded access would be bad for wildlife in the area. Murphy Oil responded with an innovative plan to construct a road in the dry creek bed, using snow and ice. Because the area is very sensitive, special measures were taken that are not required for all winter roads.

An existing seismic line was frozen for the first section of road, approximately 2 km. Oak matting was placed on the frozen ground with artificial snow on top of it as the roadbase. For the next section, trees were removed but the ground surface was not cut. The corridor was covered with geotextile matting, then a snow and ice roadbase and finally shale. The last section was constructed up the creek bed of Chicken Creek using geotextile matting, snow and shale. After the road was used to develop the wellsites all the materials were removed. A summer inspection showed that there had been a minimal impact on the vegetation.

While the road was in place, a staffed gate controlled access into the Upper Chicken Creek area.

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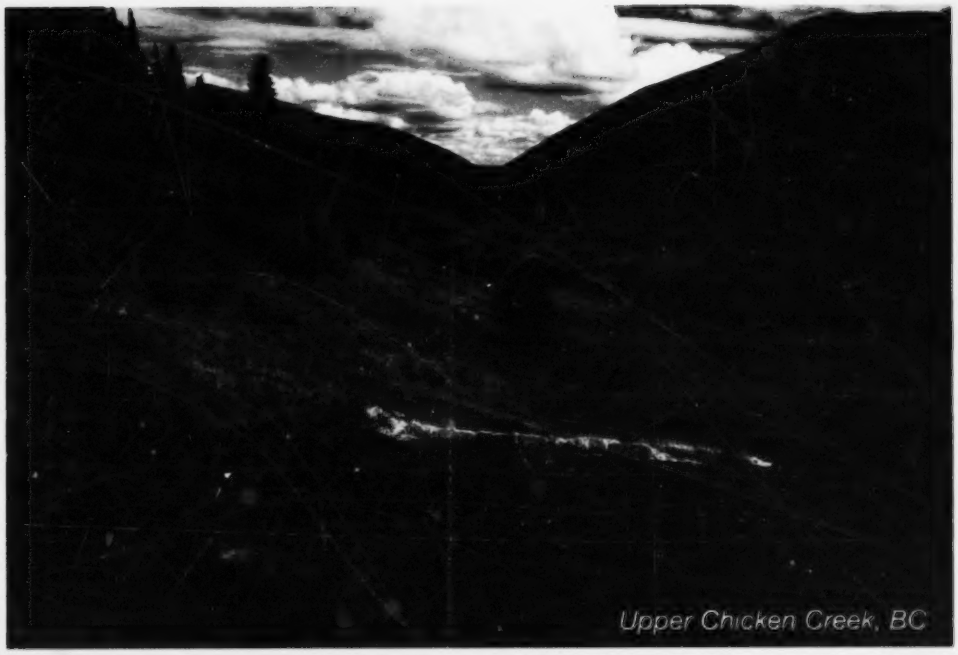

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Winter-only access roads should be routed and designed to:

- use existing cutlines, clearings, areas cleared by forestry companies or areas cleared by forest fires
- use treeless areas as much as possible
- minimize the number of creek crossings
- avoid sensitive wildlife areas such as raptor nests and bear dens
- avoid protected areas
- consider the use of lakes and other water bodies for winter access
- avoid steep slopes near watercourses

REDUCING EFFECTS

Land Use Planning

One way to ensure the impacts of new roads and trails are carefully considered is a land use plan.

Land use planning is a process that guides decision-making regarding the land and attempts to minimize and manage land-based activities such as industrial resource extraction, trapping, recreation, tourism and protected areas.

The Umbrella Final Agreement establishes how land use planning will occur in the Yukon.

Land use plans may include restrictions and guidelines on where and how roads and trails are built. They could include thresholds on the number of roads and trails in an area or limit their use to certain times of the year.

Land use planning could also coordinate access between industries to ensure new roads are not built where existing roads could be used.

Land Resource Management Plans (LRMP) in British Columbia are regionally based plans that control access. The plans are created and steered by a committee that represents various interests in the region. The Fort St. John LRMP aims to maintain wilderness and fish and wildlife habitats while permitting some resource development. The plan allows access proposals that conflict with significant wildlife values to be limited, restricted and occasionally prohibited. Under these circumstances proponents are guided to find alternatives. As well, the plan directs that new roads and corridors be managed so unnecessary ones are deactivated.

The Muskwa-Kechika Management Area was established through the work of the Fort St. John and Fort Nelson Land Resource Management Plans. They agreed that the Muskwa-Kechika was unique and should be managed to allow resource development to continue while accommodating and protecting important wildlife and environmental values. Photo: Wayne Sawchuk.

Animal dens and roost trees *(used by birds) should be identified and avoided.*

How and when a road or corridor is built will determine in part what kind of impact it has on wildlife.

- Work should not be done during sensitive times for wildlife such as fly season, cold weather in late winter, late pregnancy and calving. Stream crossings can cause excessive siltation, so construction should not conflict with fish migrations or spawning.

- Greater width makes travel corridors more obvious and accessible to predators and humans. Width also affects snow condition and regeneration time for vegetation. Linear corridors should be as narrow as possible. Doglegs in pipelines reduce the line of sight at critical locations such as intersections with roads.

- Roads should cross streams at right angles to minimize damage to riparian vegetation. Snow and ice-fill crossings should not contain soil or debris and should be removed when finished to avoid ice damming in spring. Culverts must be designed to allow fish passage.

- Along natural wildlife corridors such as drainages and ridge lines, vegetation should be encouraged to the edges of the road where this does not create a hazard.

- Linear corridors should allow wildlife to see clearly to the other side. Snow piles along roads should be avoided.

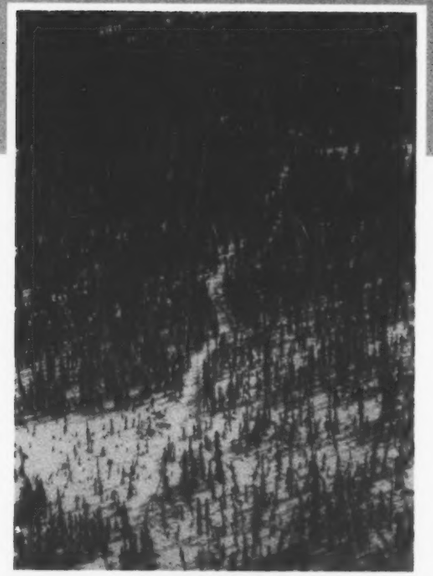
REDUCING EFFECTS

Design and Construction

Seismic exploration is used in the oil and gas industry to determine the likelihood of finding oil or gas deposits in an area. To figure out the subsurface features a series of explosions are set off at regular intervals along the ground. In forested areas corridors are cut to allow access for seismic equipment and crews. These corridors are called seismic lines. They can be several kilometres in length.

Old technique seismic line in Eagle Plains, Yukon.

Traditional seismic techniques require removing vegetation to create long straight lines of sight. New techniques like Global Positioning System (GPS), allow crews to walk around sensitive areas and cut narrow, crooked lines through the bush. Lines in a meandering pattern that don't provide a straight line of sight are less likely to provide access to humans and predators. Companies can use GPS technology to survey from helicopters. Helicopters can also be used for moving equipment and workers, decreasing the need for access roads.



Top: New technique seismic line in Eagle Plains is much narrower and meandering than the old seismic line on the previous page. This makes it much harder for us, and for predators, to see and use.

Left: Heliportable seismic.

Helicopters should not be used during crucial periods in the life cycles of wildlife, such as mating and migration. Doing seismic exploration in the winter when the ground is fully frozen minimizes surface impacts.

Seismic information that is collected by a company belongs to that company. Companies sometimes sell their information to other companies but this is not currently required in the Yukon. Often, competing companies will repeat exploration several times in the same area.

The effects of seismic exploration could be reduced if companies were required to share their information by selling it to other companies. If information sharing is not required by government, companies should use existing seismic lines in areas that have already been explored.

Location of Disturbance

Some areas are especially important to wildlife populations. These areas can be identified during land use planning. If a road or corridor is necessary, routing should be planned to avoid sensitive areas.

For example:

Riparian areas are the zones around water bodies such as lakes and streams. They are important for the health of water bodies and the entire ecosystem. Riparian areas supply food and shelter for fish and many animals and should be avoided.

Grizzly bears that are not habituated to roads will avoid them by more than 500 meters. Access roads in grizzly country should be routed to avoid important riparian areas by at least 500 metres. This is especially important in salmon spawning habitat where bears concentrate.

Migration routes for all species should be avoided by roads and trails.

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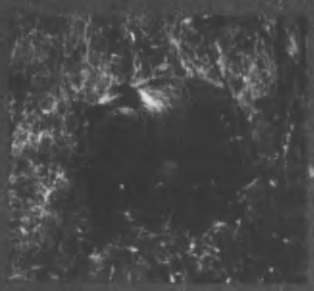


Restoration

Many roads and trails are built and used for a specific purpose and can be restored afterwards. Restoration helps the landscape return to its natural state. It makes corridors less accessible to humans and prevents further habitat damage by off-road vehicles. Restoration can include planting trees or plants, removing culverts from streams and re-contouring the land.

Duff is the decomposed organic matter that makes up the surface layer of soil. If the duff layer is kept during construction and use it is much easier to restore a corridor. The duff layer can be left in place or moved aside and replaced later.

Native plants are ones that grow naturally in an area. If non-native plants are used in replanting they can replace the natural vegetation and change the ecosystem.

Pipeline rights-of-way must be kept open for maintenance and emergencies. Wide corridors are cleared to build a pipeline but the entire width of these corridors does not need to be kept clear. Part of these corridors can be restored or allowed to recover naturally.

A restoration project underway will decompact, replant and reclaim a trail.

ACCESS MANAGEMENT

"Probably the most powerful tool available to reduce the effects of disturbance corridors on wildlife is access management, the control of human use of the development corridor." Arc Wildlife Services

Controlling or reducing the access created by roads and trails may be the most important measure in reducing their impact on wildlife.

There are several ways of dealing with the creation of new access. It is possible to leave the access available and deal with the associated hunting and fishing, or with the use of off-road vehicles.

It is also possible to control who uses a road.

While various methods for controlling access have been attempted and suggested throughout North America, generally, once you create access it is difficult to take it away. These methods all have some usefulness but the best alternative is still to avoid the creation of access wherever possible.

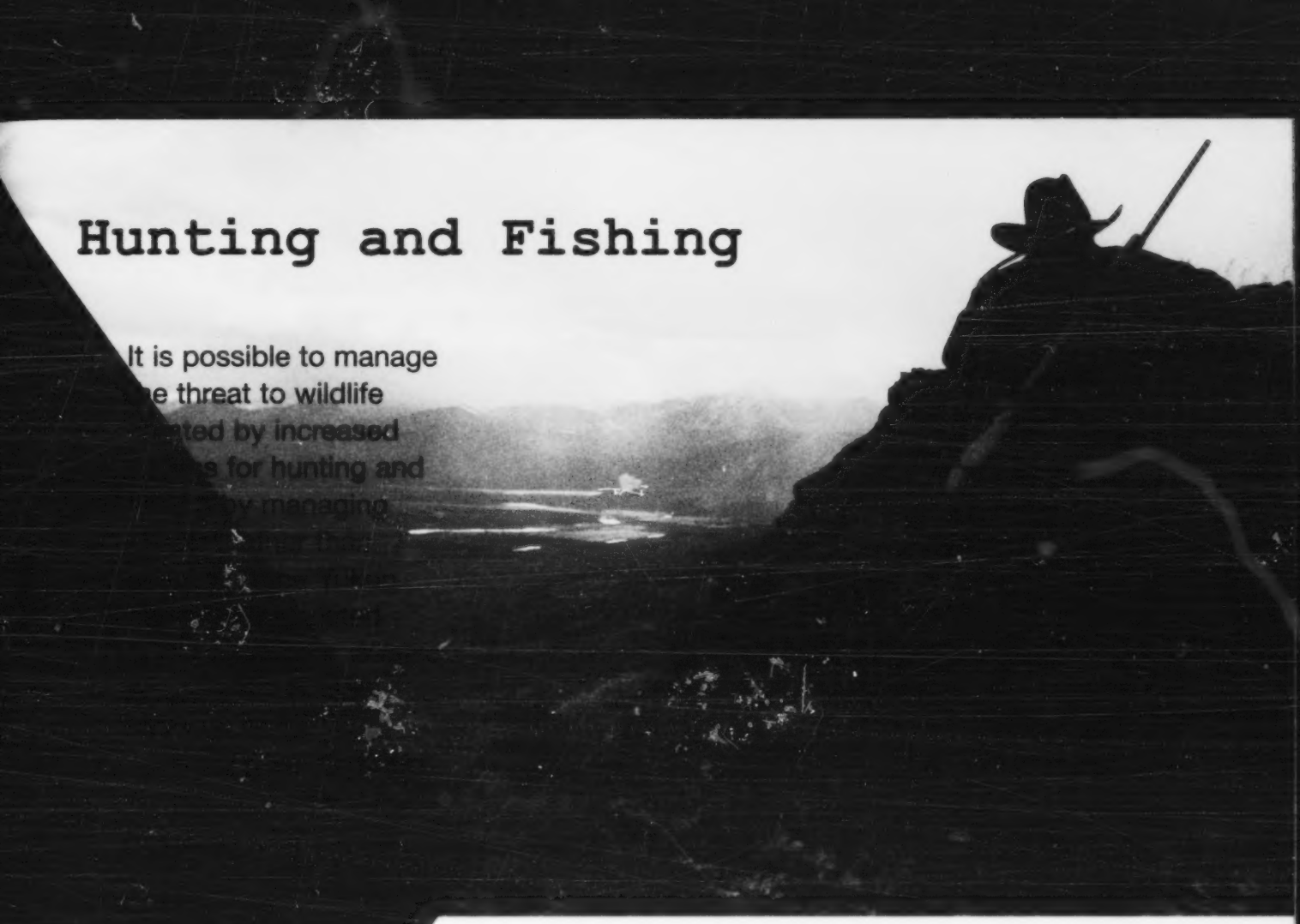
Hunting and Fishing

It is possible to manage the threat to wildlife created by increased access for hunting and fishing by managing harvest rather than access. In the Yukon harvest is regulated under the *Yukon Wildlife Act*. Some possible techniques for controlling hunting and fishing near new roads or trails include:

- **Prohibit hunting** for a specified **distance on e**ither side of a road
- **Regulate** use of vehicles for hunting
- **Prohibit** hunting along seismic lines **and** pipelines
- **Limit** harvest in defined places.
- When a road is built for industry a company can limit or prohibit hunting and fishing by staff and contractors as a condition of employment.

To be effective many of these regulations would require cooperation, complementary enactments and enforcement by First Nation governments. While these options have value in many situations there is a danger that hunters and fishers will bear the responsibility for limiting negative effects created by general access.

Hunting and Fishing



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ACCESS MANAGEMENT

Off-road Vehicles

A Yukon Game Guardian talks to snowmobile riders about good practices in caribou habitat.

It is possible to manage the impacts of ATVs and snowmobiles separately from other forms of access.

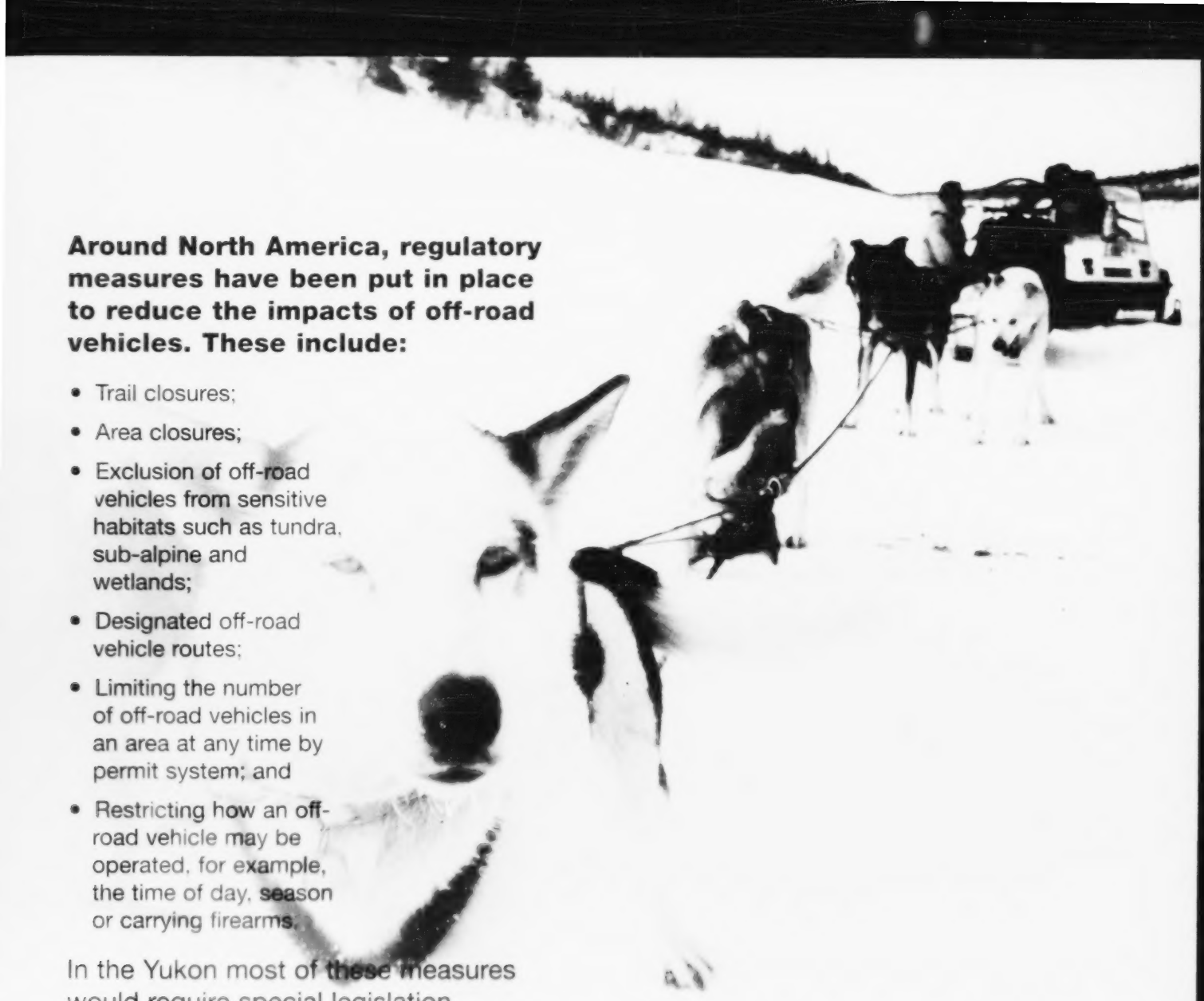
This would reduce access effects that happen beyond the road or trail as well, since roads and trails may provide initial access to an off-road vehicle but their impact often continues well beyond the road or trail.

Most off-road vehicle users use their vehicles to hunt, fish or enjoy the Yukon's backcountry. In other words, wildlife is important to them.

Education to minimize disturbance to wildlife and wildlife habitats could reduce many of the impacts of off-road vehicles.

Education could include information about areas that should be avoided by off-road vehicles during parts of the year when wildlife are sensitive to disturbance.

Stewardship programs that build awareness are best carried out by organizations that represent off-road vehicle users or the companies that sell them.

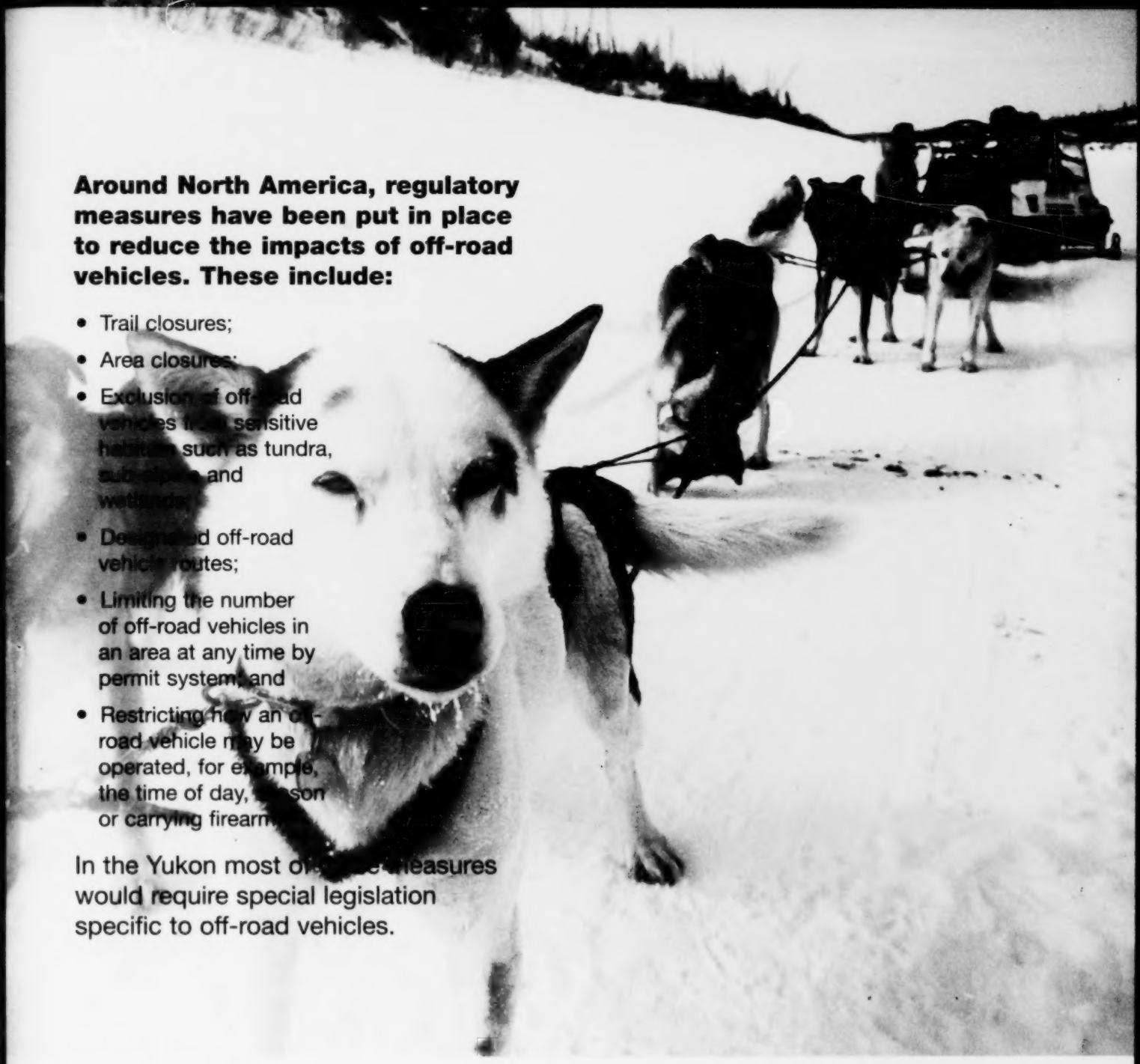


Around North America, regulatory measures have been put in place to reduce the impacts of off-road vehicles. These include:

- Trail closures;
- Area closures;
- Exclusion of off-road vehicles from sensitive habitats such as tundra, sub-alpine and wetlands;
- Designated off-road vehicle routes;
- Limiting the number of off-road vehicles in an area at any time by permit system; and
- Restricting how an off-road vehicle may be operated, for example, the time of day, season or carrying firearms.

In the Yukon most of these measures would require special legislation specific to off-road vehicles.

Managing effects that off-road vehicles have on wildlife should not unnecessarily restrict their legitimate use.



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ACCESS MANAGEMENT

Controlled Access

If you want to control access it is important to implement access control measures immediately upon creation of the road or trail.

Roads should be maintained to the minimum standard necessary. This will help deter use and promote lower vehicle speeds.

Gates can be put in place to control the use of a road.

Convoy company vehicles on industrial roads, two or more at a time, to reduce disturbance to wildlife.

Selectively plant trees to limit access points.

Avoid sensitive habitat: Rubber tires can easily damage alpine and tundra plants, which can take hundreds of years to grow back.

WHAT YOU CAN DO

There are many different ways of addressing the issues associated with new access to wilderness. None of the problems can be looked at in isolation. **Any effective strategy will require looking at all the issues and options and determining how to best address concerns around the Yukon.**

If you see a vehicle being operated in a way that would harass wildlife call **1-800-661-0525.**

If you have other concerns about habitat damage or wildlife disturbance call the Department of Environment, Habitat and Regional Management at **867-667-3645** or the Yukon Fish and Wildlife Management Board at **867-667-3754.**

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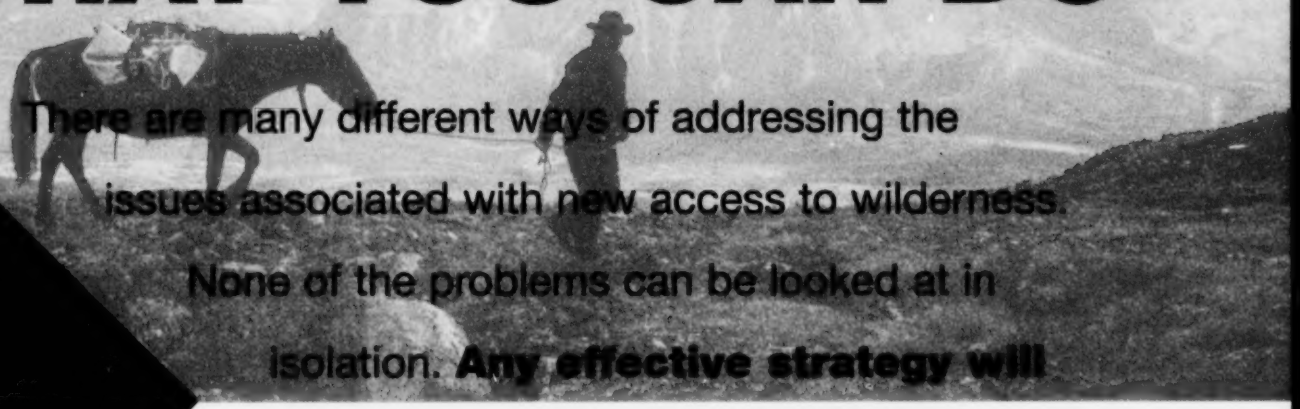

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Reporting Wildlife Disturbance and Habitat Damage

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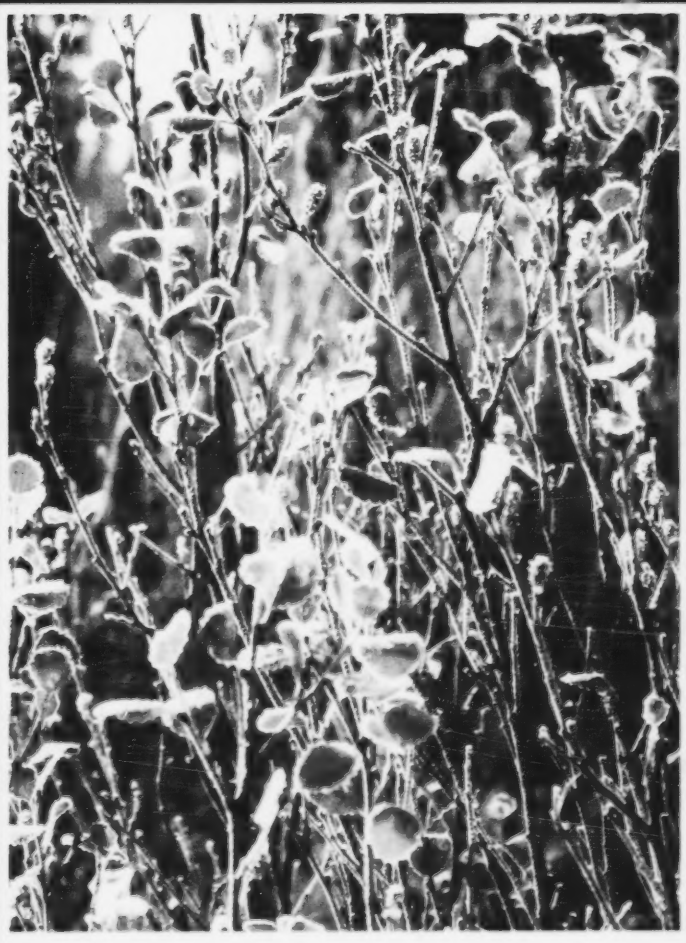
How off-road vehicle users can reduce their impact

- When driving an ORV, stay on existing roads and trails, and avoid widening or extending them. Don't cut new trails or take shortcuts- these leave scars that can be difficult or impossible to repair
- Speeding through streams is bad for fish and other aquatic life. Try to cross streams slowly and use established crossing points or bridges if possible.
- Avoid sensitive habitat. Wet or marshy areas are sensitive to disturbance. Rubber tires can easily damage alpine and tundra plants, which can take hundreds of years to grow back.
- If you see animals, slow down and keep your distance. Never chase after wildlife. Let the animals have their space, and enjoy viewing them from afar.

Communities, local groups and individuals can speed up the recovery of unused or unwanted trails.



Large projects can be expensive and require a lot of planning and consultation. However, there are some simple things that can be done to help restore trails to their natural state. Trail restoration is an excellent volunteer activity that encourages people to get involved in protecting wildlife and wildlife habitat. No work should be done near streams without consulting Habitat and Enhancement at the Department of Fisheries and Oceans.

If a community decides it wants to restore a trail it is important to keep people and vehicles from using it. People will tend to find a way around barricades and gates. It is better to plant trees densely around the access point. If the trail can't be seen people will be less tempted to use it.

- In areas where slopes are gradual and vegetation has been trampled but no soil is exposed, just removing a trail from use will often allow it to re-vegetate. In areas where the soil has been compacted you can get more involved in encouraging re-vegetation.

The first step is to treat the compaction.

If there is no risk of soil erosion compaction can be treated by loosening soil with hand tools.

- Once the soil has been loosened, you can help restore soil nutrients and organisms by spreading leaf litter and some debris from the surrounding area over the trail. You can plant or transplant trees and plants on the trail. Be sure to use only plant species that grow naturally in the immediate area. Focus plantings where there is a direct line of sight down the trail. This will discourage people from using the trail and encourage its recovery.

In areas where willows grow naturally, cuttings and transplants can be taken from existing willows and pushed into the ground to start new trees. Transplants can be taken from other willow bushes by dividing individual shrubs. Make sure to take enough root with the transplant. Cuttings can be taken either while the plant is still dormant (the buds are not swollen) or during the growing season. Dormant cuttings are taken from the previous season's growth below a bud and should be planted immediately. If you take a cutting during the growing season, cut a stem below a leaf. These cuttings need to be kept moist and planted within 24 hours. To plant cuttings make a 45-degree angle at the bottom of the cutting so they can be easily driven into the ground.

If there is a slope and soil may erode once it is loosened, vertical staking can be used. This is done by driving stakes made from branches into the ground. Vertical staking will help move water and air into the soil layers without disrupting the surface. It also creates a visual barrier to access. Leave the stakes in the ground and allow the natural vegetation to grow back.

Logs and debris can be put in natural patterns on trails. They create a natural appearance and, if laid across slopes, will help control erosion.

Spreading leaf litter and debris helps restore soil nutrients when restoring roads.

Vertical stakes made from cut branches driven into compacted ground can help loosen soil without disturbing surface stability.

Photos: Andropogon Associates

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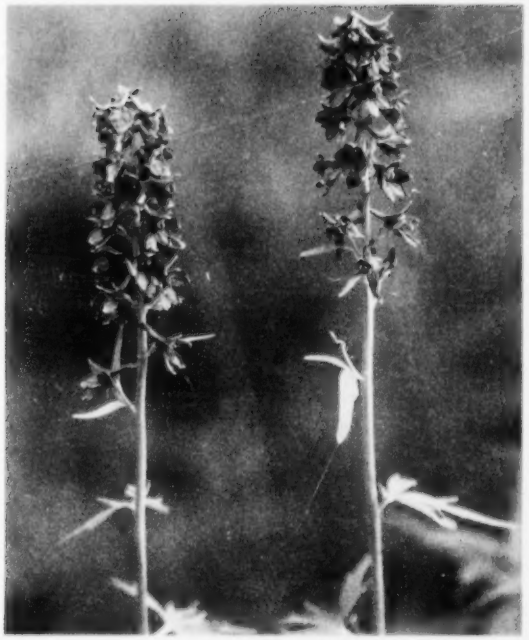

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Down the Road: The Effects of Roads and Trails on Wildlife